The University Senate of Michigan Technological University
Proposal 27-26
(Voting Units: Academic)

Graduate Certificate in Data Science-Enabled Environmental Sensing

Basic Program Information

Primary Contact: Laura Brown, Professor - Computer Science
Program / Degree type: Graduate Certificate
Program Title: Graduate Certificate in Data Science-Enabled Environmental Sensing
Planned Implementation Date: Fall 2026
Program location / modality: Face to face
Target student Population: Current students
The new certificate is targeted towards existing graduate students in the several degree programs including MS of Data Science, MS of Applied Computer Science, MS Applied Ecology, MS in Geographic Information Science, PhD Forest Science, PhD Atmospheric Science, PhD Environmental Engineering, PhD Computational Science & Engineering, and more. Additionally, other graduate students with sufficient programming and environmental domain expertise may benefit from the new graduate certificate (for example, students with a background in environmental data science, computational biology, forestry, environmental science, and more).

General description and characteristics of program

The certificate in Data Science-Enabled Environmental Sensing (DataSEES) is a 9-credit graduate certificate designed for students to gain knowledge in using data-science enabled approaches to address complex environmental problems. The curriculum of the certificate will integrate with required or elective course requirements in several graduate programs, e.g., Data Science, Applied Computer Science, Biological Sciences, Environmental Engineering, Geographic Information Science, Forestry, etc.

Rationale

Climate change and environmental problems are one of the most complex issues that humankind is facing today[1]. These have induced irreversible and irreparable damages to the environment we live in: land, water, and the atmosphere[2]. Addressing these damages requires understanding and adjusting to the actual or expected future climate; where the goal is to

[1] *Climate Change: Evidence and Causes: Update 2020.* Washington, DC: The National Academies Press, 2020.
[2] NOAA National Centers for Environmental Information (NCEI), “US Billion-dollar Weather and Climate Disasters”

reduce our risk from harmful effects of climate change on the environment and surroundings including intense extreme weather events, threats to forests (including pest outbreaks, fires, drought etc.), changes in aquatic ecosystems (induced by warming water temperature, lowered pH etc.), and changes in air quality among others[3].

Data science and AI have become a driving force of current and future innovation in research and industry. The demand for skilled professionals continues to grow rapidly. Based on the 2025 Future of Jobs Report by the World Economic Forum, AI and big data analysis will become the leading technical skills required by employers in 2030[4].

This certificate offers students interdisciplinary, post-graduate skills in data science-enabled environmental sensing. Students completing the certificate will begin their development as future researchers and scientists at the intersection of computing, sensing, and environmental application domains. The data science lifecycle will frame base knowledge for students across these knowledge areas. We plan to offer the certificate in-person.

Related programs: within MTU and at other institutions

Related Programs within MTU[5]:

- Certificate in Data Science Foundations - a 9-credit certificate that focuses on the understanding of data science tools, technologies and techniques.
- Certificate in Advanced GIS for Natural Resources - a 9-credit certificate focusing on generating, managing, visualizing, and processing data in ArcGIS an industry standard software tool
- Certificate in Foundations in Geographic Information Science for Natural Resources - a 9-credit certificate to prepare students to analyze, code, visualize, and process various geospatial datasets.
- Certificate in Remote Sensing for Natural Resources - a 9-credit certificate to prepare students with advanced proficiency in analyzing large remotely sensed data. This certificate along with the prior two form a stackable MGIS program.
- MS in Applied Computer Science - a MS degree program that focuses on the practical application of computing technologies to solve real-world problems, offering students a robust curriculum to prepare them for careers in industry and applied research.
- MS in Data Science - a MS degree program that equips students with the skills and knowledge needed to analyze complex data, develop predictive models, and derive actionable insights, with a focus on machine learning, big data analytics, data visualization, and data management.
- MS in Geographic Information Science - a MS degree program that provides students with foundation in geospatial principles and analysis.

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[3] National Academy of Sciences, *Climate Change and Ecosystems.* Washington, DC; The National Academies Press, 2019.

[4] World Economic Forum *Future of Jobs Report*, 2025. https://reports.weforum.org/docs/WEF_Future_of_Jobs_Report_2025.pdf

[5] Program descriptions coming from web pages on the Graduate School. https://www.mtu.edu/gradschool/programs/degrees/

Multiple PhD programs may have students with the prerequisite background knowledge.

Related Programs at other Institutions:

- University of Wisconsin - Certificate in Conservation Data Management and Analysis
- Penn State World Campus - Graduate Certificate in Remote Sensing and Earth Observation
- University of Southern California - Graduate Certificate in Remote Sensing for Earth Observation
- Missouri State University - Certificate in Environmental Monitoring and Sampling
- University of Connecticut - Certificate in Remote Sensing and Geospatial Data Analysis
- Southern Oregon University – Certificate in Environmental Data Science
- Grand Valley State University – Environmental Remote Sensing
- University of Houston – Earth & Environmental Data Science Certificate

This certificate is distinguished by its interdisciplinary design that emphasizes both the computational analysis as well as the sensors and sensing technologies as applied to various problem domains.

Projected Enrollment

The table below shows expected enrollment. We expect interest to be high among students from the MS in Data Science, MS in Applied Computer Science, MS in Biological Sciences, MS in Geographic Information Systems, MS in Environmental Engineering, and PhD programs in Computational Science and Engineering, Biological Sciences, Forest Science, Atmospheric Science, Environmental Engineering, and more.

Table 1. Projected enrollment per year

Academic Year	**2026-2027**	**2027-2028**	**2028-2029**	**2020-2030**
Projected Enrollment	5	7	9	12

Specialized Accreditation Requirements

Not applicable

Professional Licensure Requirements

Not applicable

Curriculum Details

Learning Goals

Upon successful completion of the graduate certificate, students will be able to:

1. Demonstrate knowledge of sensors and sensing technologies or computational methods.
2. Apply or design practical data science solutions for real-world environmental problems, around the data science lifecycle: problem identification, obtain data, understand the data, apply computational methods, and communicate findings.

Assessment Plan

The following table describes the assessment points for the graduate learning outcomes (GLO) and in what course the assessment(s) will occur.

Assessment Points for Graduate Learning Outcomes (LOs)	**Learning Outcomes addressed**	**Notes on Assessment**
Demonstrate knowledge Sensing / Computation	GLO 1	Evaluation form filled out by course instructor of DATA 5891
Apply Solutions using DS Lifecycle	GLO 2	Evaluation form filled out by course instructor of DATA 5891
Grades in courses	GLO 1, GLO 2	Excellent: all As Satisfactory: no grade <= B Marginal: only one grade <= B Deficient: more than one grad <= B

Data Compilation Plan

Course instructors will assess students on the two learning objectives using specific evaluation forms and rubrics (see table below for sample rubrics). The forms will be available as a Google Form / Spreadsheet for course instructors to input their evaluation. Results will be merged and summarized.

GLO	Deficient	Marginal	Satisfactory	Excellent
GLO1: Demonstrate a understand of sensing or computation	Unable to demonstrate understanding of sensing or computation	Displays a limited understanding of sensing or computation	Displays a good understanding of sensing or computation	Demonstrates an exemplary understanding of sensing or computation

GLO2: Apply solutions using a data science lifecycle	Improper use of data science lifecycle to design / apply methods	Displays a basic understanding of data science lifecycle to design / apply methods but has some misapplications.	Displays a solid understanding of the data science lifecycle to design / apply methods.	Displays a mastery of data science lifecycle to design / apply methods. Creates elegant and efficient solutions.

Student's grades will be collected from Banner each year. The grades will be mapped to the proficiency levels in the table. A summary report will be created that indicates the number of students that are deficient, marginal, satisfactory, and excellent.

Curriculum Design

The graduate certificate will require 9 credits:

Required:

- **DATA 5891** - Data Science for Environmental and Remote Sensing (3 credits)
  Prerequisite: UN 5550 (or Python experience)
  A student team, project-based course. Students will work in teams to complete a project using real-world remote sensing or environmental data. The course will have sections related to computational analysis, sensors, and sensing, as well as application to real-world problems.

Take 2 additional courses, from separate knowledge areas, and at least one course must be 5000-level:

- Sensors and Sensing Technologies:
  - EET 4253 - Data Acquisition and Signal Processing - 3 cr.
    Pre-req: EET 3131
  - EE 5522 - Digital Image Processing - 3 cr.
    Pre-req: None
  - FW 5560 - Digital Image Processing: A Remote Sensing Perspective - 4 cr.
    Pre-req: FW 5540
  - FW 5580 - UAS (Drone) Remote Sensing and Photogrammetry - 2 cr.
    Pre-req: MA 1032 and (FW 3540 or FW 5550)
  - SU 5010 - Geospatial Concepts, Technologies, and Data - 3 cr.
    Pre-req: None
  - SU 4140 - Photogrammetry & UAV mapping - 4 cr.
    Pre-req: None
- Computational Analysis:
  - CS 4801 - Foundations of Machine Learning - 3 cr.
    Pre-req: DATA 2201 and (MA 2710 or MA 2720 or MA 3710 or MA 3720)
  - CS 5841 - Deep Learning - 3 cr.
    Pre-req: CS 4801

    - EET 4501 - Applied Machine Learning - 3 cr.
      Pre-req: SAT 4310 or SAT 4650
    - GE 5515 - Python for Geospatial Analysis - 3 cr.
      Pre-req: GE 5280
    - GE 5870 - Geostatistics & Data Analysis - 3 cr.
      Pre-req: None
    - SU 5012 - Geospatial Data Mining and Crowdsourcing - 3 cr.
      Pre-req: None
- Application Domains
    - BL 5421 - Lake Superior Exploration - 3 cr.
      Pre-req: None
    - FW 5421 - Climate Change and Forested Systems - 3 cr.
      Pre-req: None
    - FW 5540/5541 - Remote Sensing of the Environment - 3 cr. / 1 cr.
      Pre-req: None
    - GE 4250 - Fundamentals of Remote Sensing - 3 cr.
      Pre-req: PH 2200 and MA 2160
    - GE 5150 - Advanced Natural Hazards - 3 cr.
      Pre-req: None
    - ATM/CH 5515 Atmospheric Chemistry - 3 cr.
      Pre-req: CH 3510 or CH 3520 or ENVE 4504 or CEE 4504

Alternative courses may be approved by the graduate program director.

New Course Descriptions

None. All courses are in the course catalog.

Model Schedule

Students may start the certificate in either Fall or Spring. While no formal restrictions apply, it is suggested that students complete their courses in the 2 knowledge areas, before taking DATA 5891 - a project-based course. Below are several examples of model schedules given different student's backgrounds and graduate areas of study.

- Student with Computational Background
  Fall: FW 5540 / FW 5541
  Spring: CS 5841
  Fall: DATA 5891
- Student with Environmental Data Science Background
  Fall: CS 4801
  Spring: FW 5560
  Fall: DATA 5891

- Student with Geological Engineering Background
  Spring: GE 5515
  Spring: GE 4250
  Fall: DATA 5891
- Student with Biology Background
  Spring: EET 4501
  Summer: BL 5421
  Fall: DATA 5891

Faculty Qualifications

The faculty listed below have all taught at least one of the courses in the curriculum.

- Dr. Laura E. Brown - Professor, Computer Science
  Expertise in Data Science, Machine Learning, and Computational Analysis; taught CS 4801, CS 4811, CS 5811, UN 5550, and more
- Dr. Timothy C. Havens - Professor, Computer Science
  Expertise in Machine Learning and Computational Analysis; taught CS 5841, UN 5550
- Dr. Sujan Kumar Roy - Assistant Teaching Professor, Computer Science
  Expertise in Data Science, Machine Learning, and Computational Analysis; taught CS 5841, UN 5550
- Dr. Shiliang Wu - Professor, Geological and Mining Engineering and Science; Civil, Environmental, and Geospatial Engineering
  Expertise in Air Quality, Atmospheric Chemistry, and numerical simulation with global atmospheric models; taught CEE 4504; ATM 5515; Chem 4515; GE3250
- Dr. Ashraf Saleem, Assistant Professor, Applied Computing
  Expertise in sensing and sensor technologies, Machine learning for remote sensing, and Robotics; taught EET3131 and EET4253
- Dr. Evan Lucas, Assistant Professor, Computer Science
  Expertise in Machine Learning; taught CS 5841, CS/EE 5821.

Program-specific policies, regulations, and rules

The graduate student handbook for data science would serve as a base to establish the policies and rules for this new Graduate Certificate.

Resources Needed

Library and other learning resources

No additional library or learning resources are needed.

Suitability of existing space, facilities, and equipment

Current facilities and computing resources are sufficient to start this program. Initially, courses will use existing computational resources on-campus or through existing contracts for cloud-based services.

Program Costs

The certificate is designed to use or adapt existing courses. Depending on enrollment, additional teaching and computing resources may be needed.